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Intelligence Report

Office of Transnational Issues *3 November 2000*

China: Ways To Reduce Carbon Emissions

Participation in the Kyoto Protocol's carbon permit trading program would be the most effective way for China to lower future carbon emissions, Participation in the Protocol's Clean Development Mechanism (CDM) program would lead to increased foreign direct investment but would not significantly lower carbon output.

- Compared to a business-as-usual case, participation in Kyoto's carbon permit trading system could cut China's carbon emissions by 15 - 23 percent in 2010 and generate $4 - $12 billion in annual revenues from carbon permit sales.

- Participation in CDM could cut carbon emissions by 1 - 2 percent in 2010 and generate additional annual capital inflows of $1 - 2.5 billion.

If Beijing rules out participation in Kyoto Protocol mechanisms, an aggressive import program of clean energy technologies could achieve greater carbon emission reductions than CDM but is unlikely to match reductions from carbon permit trading, according to CIA estimates.

- Japanese and European companies are aggressively marketing renewables and environmental energy equipment, and US companies would have to offer similar incentives to be competitive.

Existing economic models provide a good indication of some but not all of the economic impacts from implementing the Kyoto mechanism. Imposing a carbon tax to reach targeted emission levels under trading would cost China tens of billions of dollars annually in foreign direct investment and slow economic growth. Alternatively, CDM and an aggressive clean technology import policy would provide small economic gains and boost Beijing's technology transfer goals.

- Aside from the use of a carbon tax, China could achieve the emission reductions necessary for trading by reducing energy use, enforcing tough emissions regulations, providing incentives for conservation, restructuring industry, or slowing growth.

Scope Note: A Study On Ways China Could Reduce Carbon Emissions

This study was undertaken by the CIA to assess the environmental and economic impact on China of several proposals to reduce China's emissions of carbon dioxide. The assessment includes analysis of the Kyoto Protocol's mechanisms—carbon permit trading and the Clean Development Mechanism (CDM)—and an aggressive import program for clean energy technologies.[1]

[1] For the purposes of this report only, clean energy technologies are defined as clean coal and non-coal fueled technologies, including nuclear, hydropower, and renewables.

[2] See Appendix A - Trading Assumptions

[3] Comprehensive assessments of the Kyoto Protocol's mechanisms' impact on China's economy have suffered from the inability of any single model to simulate the complex interaction between China and its major trading partners and provide a forecast for China's domestic economy, carbon emission levels and energy mix. Previous forecasts from economic models suffered from old data and are difficult to compare because of different assumptions.

What Is the Kyoto Protocol?

The Kyoto Protocol to the UN Framework Convention on Climate Change calls for most industrialized countries and some Central European countries (defined as Annex B countries) to make legally binding reductions in greenhouse gas emissions. Most Annex B countries must reduce their emissions between the years 2008-2012 by an average of 5 percent to 8 percent below 1990 emission levels. China, like most developing countries, is under no obligation to reduce its emissions.

- The Kyoto Protocol was adopted in December 1997 at the third Conference of the Parties (COP3) following the Earth Summit in Rio de Janeiro in June 1992 where the US and 153 other countries agreed to reduce greenhouse gases.

The Kyoto Protocol creates three mechanisms for reducing carbon emissions—carbon permit trading, the Clean Development Mechanism (CDM), and joint implementation.[4] A trading system for carbon credits (permits) would be created for countries accepting binding carbon emission targets. Carbon emission reductions below targeted levels could be converted into carbon permits and sold to other countries to help them meet their targeted levels. The Kyoto Protocol would improve global carbon emission reporting systems and create 'expert review teams' to assess how nations are living up to their commitments.

A committee would also be created to administer CDM. Although what would qualify as a CDM project is still under discussion, potentially anything aiding in the abatement of carbon emissions—from planting forests (creating a carbon sink) to converting homes or power plants using coal to gas—would count. A host country would not have to have a carbon emission target to participate in CDM, rather the project developer would receive carbon credits—called certified emission reduction units (CERs)—for the project's incremental carbon emissions reduction from a baseline figure. It has not been decided whether CERs would be tradable.

- A builder of a new power plant would be awarded CERs only for the amount of carbon emissions below the baseline emissions figure for power plants agreed upon for that region of the country.

The Kyoto Protocol becomes international law 90 days after ratification by 55 countries making up at least 55 percent of 1990 Annex B countries' carbon dioxide emissions.

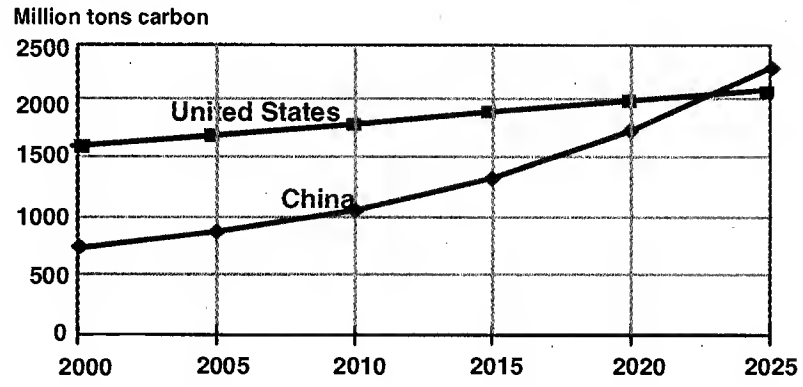
[4] Joint Implementation is a project-based emission reduction mechanism that is available only to Annex 1 members, which currently excludes China because it has not agreed to an emissions target.

China and Carbon Emissions: An Overview

China is the second largest emitter of carbon dioxide and may overtake the United States to become the largest emitter of carbon by 2023.[5] Efforts to reduce carbon emissions worldwide will have limited success without China's participation. The Kyoto Protocol provides several mechanism to reduce global carbon emissions.

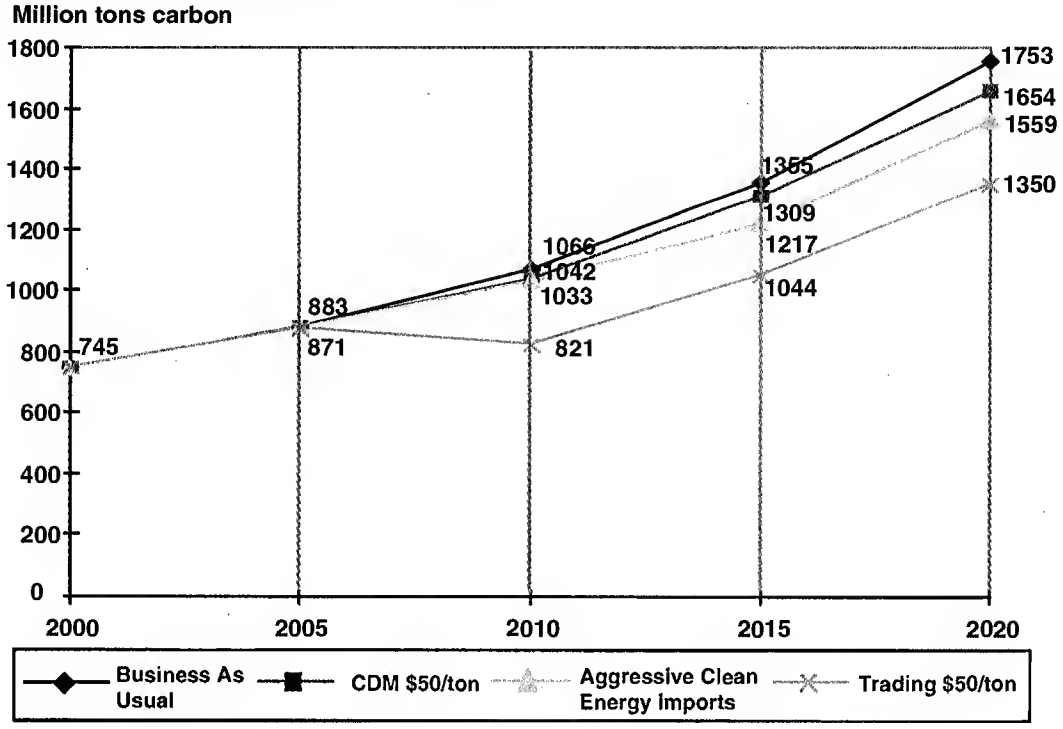
- Climate change issues in China suffer from a lack of attention from senior level officials, leading to a "just say no" attitude in negotiations. officials are waiting for the completion of studies by Chinese researchers before adopting a stand on carbon emissions.

Projected US And China Carbon Emissions



Source: Data plotted from IEA and CIA estimates.

China Emissions Forecasts



Source: CIA Projections

The Business-As-Usual (BAU) forecast for emissions is the baseline to assess emission reductions by the Kyoto Protocol mechanisms and the aggressive clean energy import program. BAU is based upon agreed assumptions for GDP growth rates for the period, energy development—such as gas and hydroelectric, carbon emissions (see Table 1). Key variables for the BAU case include an assumption of 7.5 percent annual GDP growth until 2010 declining to 6.8 percent by 2020, and a middle range of Chinese official forecasts for primary energy mix over the period.

Officially stated mid-range gas development plans are ambitious, rising from 25 bcm in 2000 to 120 bcm by 2010. Development of nuclear and hydroelectric power capacity increases by 2010 from 2 GW to 19 GW and 70 GW to 125 GW, respectively.[6]

[5] Our model forecasts China's carbon emissions exceeding US emissions in the year 2023, assuming an economic growth rate of 7.5 percent between 2000 and 2010, slowing to 6.75 percent by 2020 and a robust development of non-coal energy sources.

[6] Gigawatts (GW); billion cubic meters (bcm)

Carbon Permit Trading Offers Greatest Emission Reductions

The study indicates that China would abate the greatest amount of carbon emissions and realize significant revenue flows under the Kyoto Protocol's permit trading system. The study looked at two international permit prices for carbon—$25 and $50/ton—to gauge the impact of different carbon pricing. At $25/ton China could achieve carbon emissions reductions of 15 percent and generate 160 million permits which would result in $4 billion in revenues in 2010 if all were sold. At $50/ton China could achieve carbon emissions reductions of 23 percent and generate 245 million permits which would result in $12.2 billion in revenues in 2010, if all were sold.[7]

- Five other studies by western economists generated similar estimates for China's carbon emission reductions of 14 - 24 percent, and permit sales revenues of $4 billion - $10 billion with carbon prices of $22/ton - $29/ton,

Carbon emission reductions under a system of trading permits occur as individuals, firms, and governments seek ways to reduce carbon usage and generate revenues from permit sales. In most trading models emission reductions closely track with reductions in energy consumption, indicating that reductions are driven more by improving energy efficiency in the economy rather than through fuel-switching. Indeed, revenues generated from permit sales are sufficient to fund only a fraction of new investments in the energy sector that could abate the forecast emission reductions, according to our analysis.

- For example, $4 billion in permit revenues would fund only about three 1,000 MW nuclear reactors with a combined annual emission abatement of only 4.5 million tons per year.

[7] For every carbon permit sold, one ton of carbon must be abated. See Box: How Does Carbon Permit Trading Work?

[8] The Economics of Greenhouse Gas Emissions Abatement In China, A Preliminary Analysis, US Council of Economic Advisors, September 1999, p. 17.

How Does Carbon Permit Trading Work?

Carbon permit trading reduces carbon emissions by initially establishing a ceiling—the sum of each country's carbon emission targets—and over time reducing the ceiling as countries agree to lower target levels. To engage in carbon trading a country must agree to a binding emission target and reduce its emissions below target to produce any permits. The means by which a country would lower its carbon emissions is not specified by the Kyoto Protocol.

- Sulfur permit trading systems have already proved effective in the United States in reducing sulfur dioxide emissions, according to industry experts.[9]

Each country has a unique cost curve for reducing carbon emissions reflecting costs associated with the installation of environmental technologies and equipment, or substituting or reducing high carbon emitting fuels for lower carbon or non-carbon emitting fuels, such as replacing gas for coal, or building hydroelectric dams rather than coal-fired power plants. Countries that use the most carbon emitting fuels or are the least efficient in energy consumption are likely to have the lowest costs for carbon abatement.

- Western economists consider China to potentially have the world's lowest costs for carbon abatement.

Initially, the cost of reducing carbon would be relatively low but costs rise as increasing amounts of carbon emissions are reduced. Some countries will find it cheaper to buy carbon permits than reduce their carbon output and thus postpone adjustments. Under a market system for permit trading the lowest cost producer of carbon emissions will reduce its carbon emissions and sell carbon permits until the cost of abatement becomes equal for both buyers and sellers—the market clearing price.[10]

[9] Studies of the costs of a sulfur permit trading system in the US before it began in 1990 forecasts prices as high as $1,200/ton; however, traders now price a permit at about $151, indicating that more low-costs methods of reducing sulfur emissions than expected.

[10] Some producers will be able to reduce their carbon emission by a greater amount than would be needed to meet their emissions target and so will generate carbon permits.

China's Carbon Emission Reduction Policy Options

The most effective way for China to meet its carbon reduction target under a carbon permit trading system would be to reduce energy subsidies, which promote inefficiency and waste. Despite improvements in recent years in energy efficiency, China could still make substantial improvements in areas of the economy, such as heavy industry, that use energy intensively.

- An IEA study in 1999 reported that ending energy subsidies in China would lead to a 9.4 percent decline in energy consumption and could cut carbon emissions by 13.4 percent.[11]

- China's energy intensity relative to GDP in 1995 was four times the world average, twelve times that of Japan's, and seven times that of the United States, according to a Chinese research institute affiliated with the State Development and Planning Commission.

Further emission reductions could come from structural changes in the economy such as shifting to less energy-intensive industries or scrapping old low-efficiency equipment. Improved energy efficiency could also come from new energy and environmental legislation along with greater enforcement efforts to boost energy conservation. Since 1998 Beijing has aggressively reduced coal consumption and increased the use of substitute fuels for coal. Automotive fuel taxes have been widely used in Europe to promote conservation, but Beijing has yet to use fuel taxes for this purpose.

- Chinese coal consumption has declined about 10 percent over the last three years, according to official statistics, due largely to closing inefficient industries. In August 2000, Chinese officials in Shenyang closed that city's smelter, which had been built operating since 1936,

- Beijing could lower energy consumption by increasing energy efficiency standards on appliance manufacturers and providing tax benefits for energy conservation.

It is unclear how politically acceptable many of these options would be for Beijing. Beijing has rejected participation in Kyoto's trading system because under the present Kyoto framework China would be required to accept a carbon emission target. Emission rate targets are normally expected to be some percentage below business-as-usual (BAU)—the level of emissions that would result from expected economic growth trends. Targets are needed in order to establish the number of permits for the system. Beijing has

[11] IEA, 1999, World Energy Outlook, Looking At Energy Subsidies: Getting the Prices Right. Paris: OECD/IEA.

adamantly maintained that economic growth would not be sacrificed for emissions targets,

- Some Kyoto negotiators have suggested that China be allowed into Kyoto's trading system with BAU as its target, or under a "no fault" provision whereby it incurs no penalties if it fails to attain its target.

- China's participation in a trading system would lower global abatement costs because most academics consider China to have many low cost options for reducing emissions.

The details of how a trading system would operate—how target achievement would be monitored and whether there would be enforcement penalties—have not yet been determined.

Clean Development Mechanism (CDM)

Our analysis showed that CDM would have minimal impact on China's carbon emissions in 2010—generating reductions of only 1, 2, and 5 percent at carbon prices of $25/ton, $50/ton and $100/ton, respectively.[12] CDM also leads to only marginal increases in capital investment of $1 billion, $2.5 billion, and $5.2 billion in 2010 at $25/ton, $50/ton and $100/ton, respectively.

- CDM's value to China may be understated by this study which does not include other benefits offered by CDM projects such as the removal of other air pollutants, additional jobs, improved public health, or incremental aid in assisting China in aggressive energy sector restructuring.

CDM is designed to increase foreign direct investment in China by providing an additional incentive—the carbon credit—for projects in China that reduce carbon emissions. What projects qualify for CDM, however, has not yet been defined and the potential exists for more broadly defined CDM projects to have greater impact in reducing China's emissions. However, CDM even in its most robust form is unlikely to achieve the emission reductions of permit trading because of its project specific nature. Some western economists speculate that the process for project evaluation and approval under CDM would be expensive and time consuming, undercutting its usefulness.

- Chinese officials are insistent that CDM provide for new transfers of technology and new investment, especially in the energy sector,

[12] Reductions of 1,2, and 5 percent correspond to cuts of 9, 24, 49 million tons of carbon in 2010.

- A World Bank study of CDM found 63 separate potential transactions costs which could discourage investors.

Our study over the next five to ten year period projects minimal development of some advanced clean coal technologies because of their high capital costs and minimal carbon savings, making them uneconomic in reducing carbon emissions. In addition, energy projects requiring long construction lead time and high up-front capital costs, especially nuclear and hydropower facilities, are unlikely to be more rapidly developed before 2010 than under official plans even with CDM.

- Integrated Gas Combined Cycle and Pulverized Fluidized Bed Combustion are uneconomic technologies for reducing carbon emissions but may appeal to Beijing once costs decline and their commercial track record is established.[13]

Aggressive Import of Clean Energy Technologies

A third method for reducing emissions outside of the Kyoto Protocol would be an aggressive clean energy technology import policy. This assumes Beijing would be supplied technologies from developed countries through soft credits and loans. Such a scenario would likely result in carbon emissions reductions just slightly greater than the $100/ton for carbon CDM case, Energy technologies would have greater penetration due to their lower cost for financing—primarily through export credits, special repayment terms and the avoidance of Kyoto administration certification or approval requirements. Carbon emission reductions under an aggressive import scenario would be less than in the trading case because of its project specific nature and the lack of a broader conservation focus.

- Beijing faults the United States for insufficient amounts of developmental assistance and concessional export financing for environmental technology,

China may require as part of the Tenth five-year plan (2001 - 2005) that a small percentage of new electric generating capacity be from renewable sources, Japanese and European companies have been aggressively marketing their environmental and energy technologies through tied-aid and soft credit terms.

[13] Integrated Gas Combustion Cycle and Pressurized Fluidized Bed Combustion technologies for coal-fired power plants have greater thermal efficiency rates than conventional coal-fired power plants but have very high capital costs and are still in development with no commercial track record of operation to prove that they will perform as economically as promised. Thus, on a dollar per ton of carbon abated these technologies are more costly than many others, including nuclear, hydroelectric and wind. (See Table 2)

- The availability of soft loans from European governments is a major factor for European wind turbines capturing 90 percent of the market,

Impact on China's GDP of Trading & CDM

The Oxford World Macroeconomic and Energy Model standard economic forecast for China was utilized to assess the economic implications for Chinese participation in Kyoto's permit trading and CDM mechanisms. The permit trading system does not lend itself to easy modeling due to the many methods possible to reduce emissions. Revenue streams to China from permit sales can be modeled but these revenues are of a secondary nature to the real economic changes that bring about emission reductions and have a minor short-term positive effect on GDP. A carbon tax is one method to reduce carbon emission which can be modeled; however, additional work on the international implications of a carbon tax may be required to identify all aspects of the complex international interactions effecting China's economy.

- Under a permit trading system, China would likely be initiating changes in regulatory and legal codes as well as further industrial restructuring that could not be accurately forecast or modeled with existing models.

- Revenue streams from permit sales did not have a significant impact on China's GDP by 2010.

Conversely, CDM's impact on China's economy can be more easily estimated by the increased investment flows that are likely to occur to finance carbon abatement projects. Increased capital flows of $10 to $20 billion annually—four to ten times the actual capital flows forecast —were processed by the Oxford model with negligible changes in the base GDP forecast over the period. Variations in the share of Chinese content in these capital flows did not significantly alter the results.

- The larger capital flows were modeled to assess CDM under its more robust potential and as an upper boundary for possible incremental capital flow increases.

- CDM is likely to provide numerous benefits, such as reduced sulfur and nitrogen emissions, in addition to the limited carbon emission reductions. Additionally, advanced safety equipment and practices are likely to be transferred with the new technology, aiding environmental clean up efforts and societal welfare in general.

Implications

Although the study found permit trading to provide the best means for China to reduce its carbon emissions, Beijing is unlikely to accept targets in the near-term. Senior Chinese officials maintain that reducing carbon output is primarily a developed country obligation and Chinese academics are still grappling with the impact of the Kyoto mechanisms on China's economy.

- In the future, Beijing may gain greater confidence in permit trading from observing European trading systems and developing its own sulfur trading system.

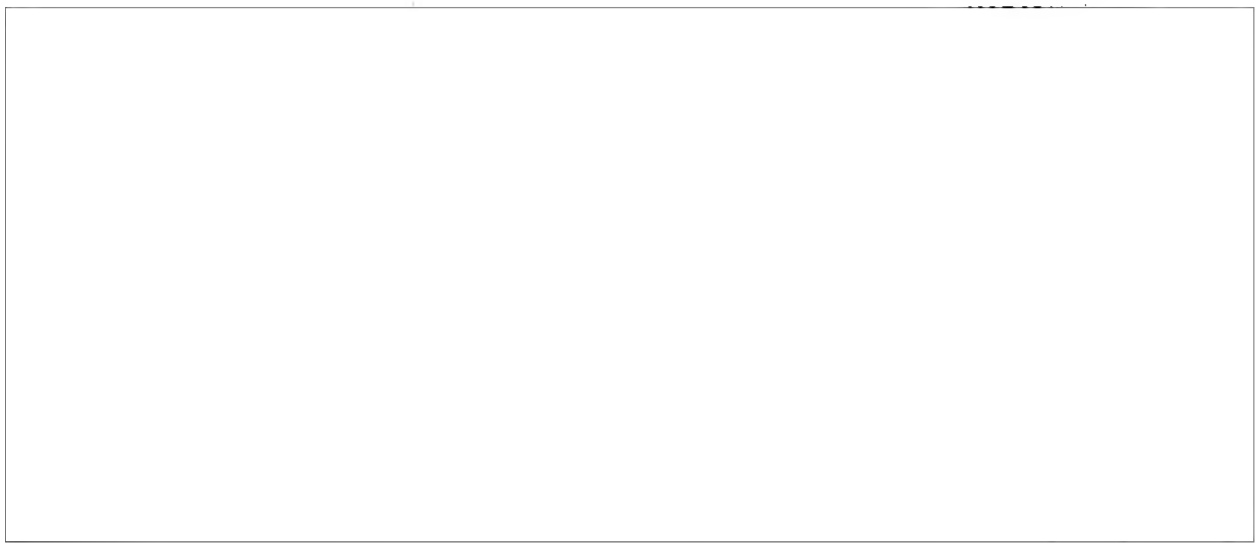
Beijing is comfortable with CDM which directly links carbon emission reductions to specific projects.

- Despite major reforestation efforts in western China that could be counted under a broad definition of CDM, Beijing favors a narrow definition, that would increase the likelihood of technology transfers.

An aggressive import program would provide greater emission reductions than CDM, but Beijing would require foreign countries to provide soft loans and easy credit terms. Competition with Japanese and European suppliers of renewables and environmental equipment will likely undercut commercial opportunities for many US firms.

- For example, US suppliers of wind-power equipment have not fared well against soft loans and tied aid offered by foreign firms.

Existing models provide a good indication of some but not all of the economic impacts from implementing the Kyoto mechanism. The models do tell us that should China implement a carbon tax to achieve its emissions target, substantial FDI and a significant fraction of GDP would be lost. Conversely, the economic impact of CDM has limited downside potential.



Appendix D: Glossary

Business-As-Usual (BAU)

The emission level forecast for a country should no effort be undertaken to lower emissions. This serves to establish a baseline for targeting emission reductions below the BAU level.

Carbon Tax

A tax on carbon to encourage fuel efficiency and switching to gas which has lower amounts of carbon than coal or oil, or noncarbon sources, such as hydroelectric, and renewables.

Clean Development Mechanism (CDM)

A mechanism of the Kyoto Protocol by which advanced countries work together with developing countries that have not taken on an emission target in emission reducing ventures. Advanced countries then could then claim some of these emission reductions as part their own emission reductions. Two other Protocol mechanisms for reducing greenhouse gases are emissions trading and joint implementation.

Clean Energy Technologies

Defined in this paper as technologies that lower the amount of pollutants from burning coal and technologies which do not use coal as a fuel source, such as renewables.

Emissions Trading

A mechanism of the Kyoto Protocol through which countries with emission targets would trade greenhouse gas emission permits for money. Countries which can reduce emissions below their target levels would be allowed to sell permits for the excess emission reductions to countries seeking to postpone more expensive domestic reductions

Framework Convention On Climate Change

A treaty for the purpose of preventing climate changes such as global warming that are due to an increase in greenhouse gases. The target of returning to 1990 levels of greenhouse gas emissions by the year 2000 was adopted in 1992

Kyoto Protocol

A protocol of the Framework Convention On Climate Change that was adopted at the Kyoto conference on preventing global warming in 1997. The Protocol determined that from 2008 to 2012 emissions of six categories of greenhouse gases are to be reduced in all of the advanced countries by 5.2 percent from those levels in 1990. The Protocol established numerical emission targets for each country.

Sinks

Forests, oceans, and other such bodies that absorb $C0_2$ are called sinks, or absorption sources. Sinks are mentioned in the Kyoto Protocol but the calculation of how much CO_2 is absorbed by any given sink is still under scientific study.

Six Gases

CO_2, Methane, Nitrogen Monoxide, Chlorofluorocarbons (both HFC, PFC), and Sulfur Hexafluoride are targeted for reduction in the Kyoto Protocol. CO_2 comprises two-thirds of the entire greenhouse effect.

Joint Implementation

A mechanism of the Kyoto Protocol by which advanced countries work together on emission reducing ventures. Two other Protocol mechanisms for reducing greenhouse gases are trading and CDM.